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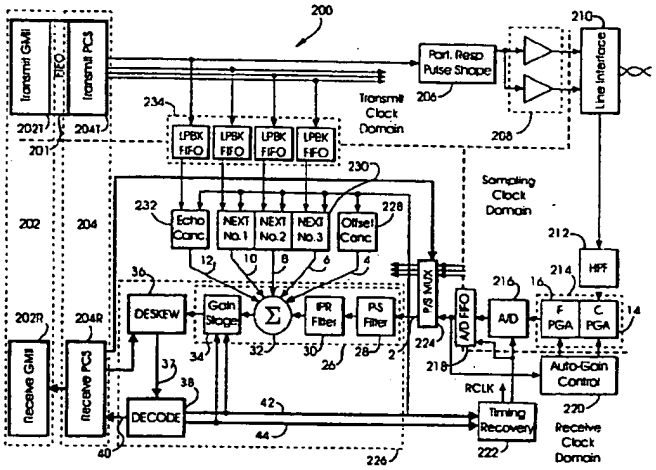
(54) Title: MULTI–PAIR GIGABIT ETHERNET TRANSCEIVER



(57) Abstract

Various systems and methods providing high speed decoding, enhanced power reduction and clock domain partitioning for a multi–pair gigabit Ethernet transceiver are disclosed. ISI compensation is partitioned into two stages: a first stage compensates ISI components induced by characteristics of a transmitter's partial response pulse shaping filter in a demodulator, a second stage compensates ISI components induced by characteristics of a multi–pair transmission channel in a Viterbi decoder. High speed decoding is accomplished by reducing the DFE depth by providing an input signal from a multiple decision feedback equalizer to the Viterbi based on a tail value and a subset of coefficient values received from a unit depth decision–feedback equalizer. Power reduction is accomplished by adaptively truncating active taps in the NEXT, FEXT and echo cancellation filters, or by disabling decoder circuitry portions, as channel response characteristics allow. A receive clock signal is generated such that it is synchronous in frequency with analog sampling clock signals and has a particular phase offset with respect to one of the sampling clock signals. This phase offset is adjusted such that system performance degradation due to coupling of switching noise from the digital sections to the analog sections is substantially minimized.

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INTERNATIONAL SEARCH REPORT

International Application No
PC.,US 99/26493

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L25/14 H04L1/00 H04L25/06 H04L25/497 H04L25/03
H04L25/49 H04L7/02 H04L7/033 H04B3/23 H04B3/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal, WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 206 770 A (CODEX) 30 December 1986 (1986-12-30) column 3, line 1 - line 9 column 4, line 15 - line 38 column 5, line 48 -column 6, line 6 column 10, line 1 - line 6 column 14, line 53 - line 55 column 16, line 27 - line 32 ---	99-122, 137-173
X	US 5 566 191 A (MAKOTO OHNISHI ET AL) 15 October 1996 (1996-10-15) column 3, line 49 - line 51 ---	137-173
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 October 2000	12 10. 2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Scriven, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
P../US 99/26493

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 159 282 A (MUTSUMU SERIZAWA) 27 October 1992 (1992-10-27) column 1, line 39 - line 54	238-271
X	EP 0 756 404 A (LUCENT) 29 January 1997 (1997-01-29) column 6, line 39 -column 7, line 2	238-271
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A	BERGMANS ET AL.: "On the use of decision feedback for simplifying the Viterbi detector" PHILIPS JOURNAL OF RESEARCH, vol. 42, no. 4, 23 November 1987 (1987-11-23), pages 399-428, XP000565157 Amsterdam, NL ISSN: 0165-5817 page 406, paragraph 1; figure 3 page 408, paragraph 1 page 409, paragraph 2	99,111
X	GB 2 219 469 A (PHILIPS) 6 December 1989 (1989-12-06) page 2, line 27 - line 31 claim 1	215-233
A	RAHELI R ET AL: "PER-SURVIVOR PROCESSING: A GENERAL APPROACH TO MLSE IN UNCERTAIN ENVIRONMENTS" IEEE TRANSACTIONS ON COMMUNICATIONS., vol. 43, no. 2-4, February 1995 (1995-02), pages 354-364, XP002059868 NEW YORK, US page 356, left-hand column, paragraph 3	99,111
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INTERNATIONAL SEARCH REPORT

International Application No
F../US 99/26493

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 99 22482 A (G2 NETWORKS) 6 May 1999 (1999-05-06) page 1, line 15 - line 18 figure 3 ---	338-377
A,P	HARATSCH: "High-speed VLSI implementation of reduced complexity sequence estimation algorithms with application to Gigabit Ethernet 1000Base-T" INTERNATIONAL SYMPOSIUM ON VLSI TECHNOLOGY, SYSTEMS, AND APPLICATIONS, 8 - 10 June 1999, pages 171-174, XP002136642 Piscataway, US page 172, left-hand column, paragraph 2 ---	99-122
A,P	EP 0 889 612 A (LUCENT) 7 January 1999 (1999-01-07) page 3, line 47 - line 55 page 4, line 40 - line 42 figure 5 -----	99,111

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/26493

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [ ] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. [X] Claims Nos.: 1-98 123-136 174-214 234-237 272-306 318-337 378-379
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [X] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[X] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 1-98 123-136 174-214 234-237 272-306 318-337 378-379

Claims searched:

99-122; 137-173; 215-233; 238-271; 307-317; 338-377.

In view of the large number and also the wording of the claims presently on file, which render it difficult, if not impossible, to determine the matter for which protection is sought, the present application fails to comply with the clarity and conciseness requirements of PCT Article 6 (see also PCT Rule 6.1(a)) to such an extent that a meaningful search on the basis of all the claims is impossible.

Consequently, the search has been carried out for those claims which do appear to be clear and concise, in that they represent, in a clear and concise manner, subject matter to which the application appears to be directed, namely claims 99-122, 137-173, 215-233, 238-271, 307-317 338-377.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 99-122

   Decision feedback sequence estimation

2. Claims: 137-173

   Computation of metrics

3. Claims: 215-233

   Removal of intersymbol interference in two stages

4. Claims: 238-271

   Regulation of power consumption

5. Claims: 307-317

   Reduction of switching noise

6. Claims: 338-377

   Timing recovery

INTERNATIONAL SEARCH REPORT

ormation on patent family members

International Application No
PC./US 99/26493

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